



1 PROJECT SUMMARY

1.1 PURPOSE OF THE RESEARCH

NASA plans to produce cryogenic oxygen and hydrogen to power regenerative fuel cells for lunar surface exploration. The oxygen and hydrogen will be provided by electrolysis of water from In Situ Resource Utilization (ISRU) reactors. The electrolysis products will be warm high-pressure gases, requiring significant cryocooler power to achieve the desired storage conditions. This power can be reduced by expanding the gases adiabatically from the electrolysis pressure to storage pressure. In particular, turboalternators can be used to maximize this effect and convert the extracted fluid power into useful electric power.

1.2 RESEARCH CARRIED OUT

Creare developed innovative turboalternator technology for this project. Small flow rates and high fluid densities require turbine rotors that are extremely small and operate at high speeds. Consequently, micro-fabrication techniques and gas bearings are key features needed create high efficiency. Gas bearings also enable reliable, long-life, maintenance-free operation. Our development effort leveraged decades of Creare experience with cryogenic gas-bearing turbomachines. In Phase I, we developed optimized turboalternator designs by conducting trade studies, specifying design details, analyzing performance, and demonstrating bearing operation with two-phase rotor flow. During Phase II, we created a complete set of fabrication drawings, developed critical fabrication processes, fabricated a prototype turboalternator, and measured its performance at ambient temperature.

1.3 RESEARCH FINDINGS

The Phase II project results indicate that our turboalternator technology will be beneficial for lunar exploration. Specifically, we project a payload mass reduction of 126 kg and an input power savings of 229 W for the system currently envisioned by NASA.